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IN THIS ISSUE

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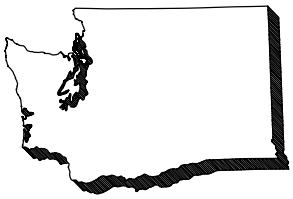

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Cover Photo: Hercules Quarry No. 6 near the Skookumchuck River and the quarrymen that worked stone for the Grays Harbor jetty (1916). The child Arthur McArthur (lower center) is sitting on the lap of John Elder. Andrew (Tim) McArthur (lower right) has the dark mustache, raincoat, and high boots. Robert McArthur (middle right) wears overalls and a machinist's cap and has his arms folded across his chest. Heinie Scheel (upper left) is standing at attention with pipe in mouth. Courtesy of South Thurston County Historical Society, Tenino, Wash.

GEOLOGIC HAZARDS PROGRAM ENHANCEMENTS

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State support for Geology and Earth Resources programs has been gradually reduced since the 1992/93 biennium, but we have been successful in supplementing state resources with grants and contracts. For instance, during the current biennium we have twelve contracts with such agencies as the Washington State Military Department (which coordinates natural disaster response), the University of Washington, the U.S. Geological Survey, the U.S. Department of Transportation, and the Environmental Protection Agency.

By 1997, the Department recognized that stable funding was needed to support division programs. The agency's published ten-year direction included, as a major action, the need to define core program elements and secure the necessary state funding. The opportunity to work towards this goal seemed elusive in light of overall state belt tightening.

Above-normal precipitation three winters in a row, from 1996 to 1999, triggered a series of disastrous landslides: the Seattle area (1996/97); the Aldercrest slide, Kelso, Cowlitz County (1997/98); the Carlyon Beach–Hunter Point slide, and Sunrise Beach slide, Thurston County (February, 1999). The Aldercrest slide has destroyed 137 homes, and another 34 homes are threatened, making this the second most damaging slide to residences in the United States. The Carlyon Beach–Hunter Point slide has affected 43 residences, and the Sunrise Beach slide has affected 20 homes.

Through the City of Seattle's Project Impact, various resources, including those of the U.S. Geological Survey, are being applied to address geologic hazards. The less populated counties such as Thurston and Cowlitz do not have the resources or expertise to identify and mitigate geologic hazards. During July of 1998, with the support of the Department, the Division prepared a geologic hazard budget request consisting of two parts: two full time-equivalent (FTE) geologists as circuit riders to assist local government and two FTEs to produce, on a priority basis, geologic hazard maps. This program would be integrated with our on-going mapping and hazard zonation work.

On April 25th, the Legislature passed the state's operating budget. Our request, as supported by the Governor, was approved. Section 308, Subsection (2), provides "$331,000 of the general fund state appropriation for fiscal year 2000 and $339,000 of the general fund state appropriation for fiscal year 2001 are provided solely for geologic studies to evaluate ground stability in high growth areas and to provide geologic expertise to small communities". During this coming fiscal year, as grants and contracts are completed, program implementation will be phased in. We will continue to request funding for geological mapping, through the National Geologic Mapping Act, that supports our core program of developing a statewide geologic database.

As State Geologist, I want to thank all individuals, and in particular local government officials, for supporting our geologic hazard initiative during the current Legislative session. ■

The Metallic, Nonmetallic, and Industrial Mineral Industry of Washington in 1998

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INTRODUCTION

Washington ranked 24th in the nation in total value of nonfuel mineral production in 1997, the last year for which production figures are available. This value, $555,430,000 compared to $535,289,000 in 1996, represents a 4 percent increase in the value of production. Figure 1 illustrates gold production in Washington over the past 14 years. The rank and value of nonfuel mineral production for each state is determined annually by the U.S. Geological Survey; however, final figures for last year are not yet available. The value of nonfuel mineral production for 1998 will be published in the first issue of *Washington Geology* next year.

The status of and activities in the nonfuel mineral industry (metallic, nonmetallic, and industrial mineral commodities) of Washington in 1998 were compiled from volunteered information obtained from an annual survey mailed to mining companies and independent miners. Several companies and individuals were contacted for additional details about their mining operation. The reader should be aware that this compilation is not a complete or thorough survey of the nonfuel mineral industry in Washington.

The status of and activities in the nonfuel mineral industry of the state, together with additional details of the geology of deposits, are published in the first issue of *Washington Geology* each year (for example, Derkey, 1995, 1996, 1997, 1998; Gulick, 1995). Inquiries about metallic and nonmetallic mining activities and exploration should be directed to Bob Derkey in the Division's Spokane office. Information and details concerning reclamation in the construction sand and gravel and stone industries can be obtained from Dave Norman in the Olympia office. See p. 2 for addresses and phone numbers.

METALLIC MINERAL INDUSTRY

Details of status and activities are presented only for major metallic mineral deposit projects. A location map together with an accompanying summary table for major metallic mineral deposit projects is provided in Figure 2 and Table 1. Small-scale mining and maintained-property metallic mineral deposit projects are listed in Table 2. Metallic mineral deposit projects accounted for about 26 percent of the total value of nonfuel mineral commodities produced in 1997.

Major Metallic Mineral Deposit Projects

All major metallic deposit projects are located in the northeast part of the state (Fig. 2). They include underground mining at the Lamefoot and K-2 gold deposits (Ferry County), announcement of reserves and initiation of an EIS for underground mining at the Pend Oreille zinc-lead deposit (Pend Oreille County), continuation of the permitting process at the Crown Jewel gold deposit (Okanogan County), and magnesium metal production from the Addy dolomite quarry (Stevens County).

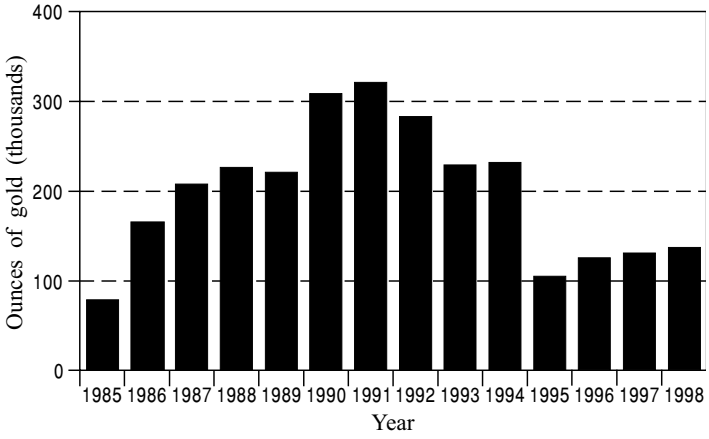

Figure 1. Gold production in Washington, 1985 to 1998. Echo Bay Minerals Co. was the only company with gold production in 1997. Their production (129,866 oz) increased by nearly 4,000 oz compared to that for 1996.

Lamefoot and K-2 Gold Deposits

Echo Bay Minerals Co. mined and produced precious metals from the Lamefoot and K-2 gold deposits (Fig. 3), located northeast of Republic in Ferry County. Collectively, the Lamefoot and K-2 deposits are known as the Kettle River Project and are the only major gold mines operating in Washington. A total of 679,029 tons of ore was processed at the company's mill near Republic (near the Overlook mine site) in 1998, compared to 771,002 tons in 1997.

Echo Bay mined 435,163 tons of ore and recovered 89,593 ounces of gold in 1998 from the Lamefoot deposit (Fig. 2, no. 1), an exhalative/replacement-type deposit in Permian rocks. The epithermal vein-type K-2 deposit (Fig. 2, no. 2; Fig. 4), in Eocene volcanic rocks of the Republic graben, produced 243,866 tons of ore. The company recovered 48,979 ounces of gold from K-2 ore. Total production from the Kettle River Project in 1998 was 138,572 ounces of gold, up from the 129,866 ounces produced in 1997.

At the end of 1998, Echo Bay reported proven and probable ore reserves at Lamefoot of 646,000 tons containing 126,300 oz of gold and possible ore reserves of 83,000 tons containing 20,500 oz of gold. Reported proven and probable reserves at K-2 include 525,000 tons containing 110,700 oz of gold and possible ore reserves of 105,000 tons containing 21,500 oz of gold. The company again continued its extensive exploration drilling program on or near their operating mines and on other properties in the region in 1998.

Pend Oreille Mine

Although startup of mining at the Pend Oreille mine (Fig. 2, no. 4) in northern Pend Oreille County is slated for the year 2002, Cominco American Inc. initiated the process to reopen the underground mine through preparation of an Environmental Impact Statement (EIS) commensurate with rules and regulations in effect in 1998. Tentatively, the draft EIS is expected to be released sometime this summer and a final EIS released sometime in late 1999. Cominco announced a reserve at this

Mississippi Valley-type zinc-lead deposit of 6.5 million tons with an average grade of 8.9 percent zinc and 1.6 percent lead.

Crown Jewel Project

Battle Mountain Gold Company continued to work toward obtaining the necessary permits to put the Crown Jewel gold deposit (Fig. 2, no. 3) in Okanogan County into production. This process proceeded in earnest following release of the EIS for the proposed mine in 1997. The company intends to begin construction of the mine and mill when the necessary permits have been obtained.

Magnesium Metal Production

Northwest Alloys Inc. (a subsidiary of ALCOA) mined about 600,000 tons of dolomite in 1998 compared to 532,107 tons in 1997. The company produces magnesium metal from the dolomite at its plant near Addy in Stevens County. The dolomite is currently mined from a quarry adjacent to the plant (Fig. 2, no. 5). Apparently the demand for magnesium metal picked up in 1998 and resulted in an increase in production. Northwest Alloys recovers calcium and magnesium lime byproducts from magnesium metal production. These byproducts are marketed as fertilizer or soil conditioners.

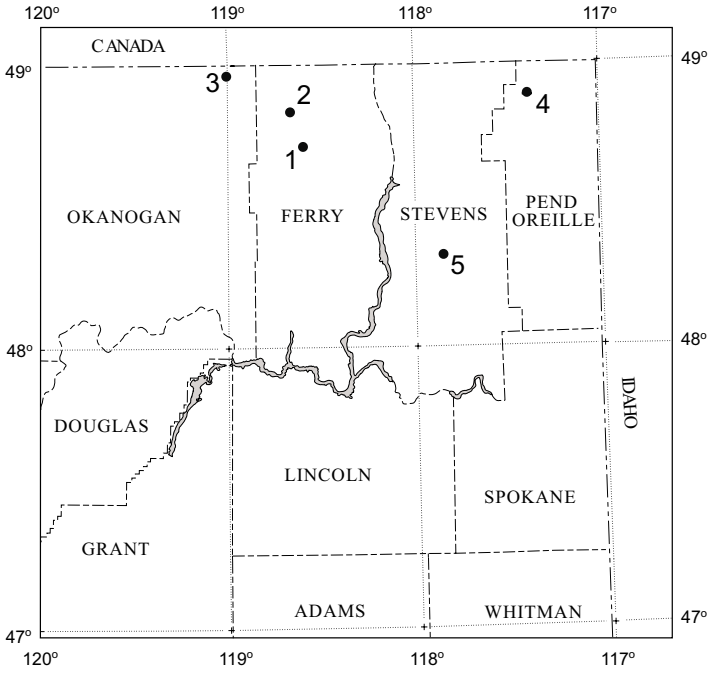

Figure 2. Location of major metal mining and exploration projects in northeastern Washington in 1998. The table below identifies mines numbered on the map.

Small-Scale Projects and Maintained Property

Table 2 lists activities at deposits for metallic commodities in Washington in 1998. This includes several companies that continued to maintain their property in 1998 and individuals and small companies who were operating in 1998.

NONMETALLIC MINERAL INDUSTRY ACTIVITIES

In 1997, nonmetallic mineral commodities (carbonates, clays, diatomite, olivine, and silica) accounted for nearly $136 million (up from $118 million in 1996) or approximately 25 percent of the $555,430 million total value of nonfuel mineral production for Washington. Figure 5 is a location map of nonmetallic mineral deposits and the accompanying table summarizes nonmetallic mineral deposit status and activities for 1998.

Carbonates

Limestone (calcium carbonate) and dolomite (calcium magnesium carbonate) deposits in Washington occur in the northern part of the state. There are two major types of limestone and dolomite deposits. The first is early Paleozoic, shelf carbonate deposited on the North American continental shelf and now occurring in the northeastern part of the state. The second consists of irregular masses of late Paleozoic and Mesozoic carbonate deposited on the ocean floor or in island arcs (many possibly as reefs) that are now accreted to the North American continent. These occur in the north central and northwestern parts of the state.

Limestone is the principal carbonate ingredient in cement. Shelf-type carbonate from Washington was mined and processed to make cement at Metaline Falls up until the early 1990s when that plant closed. Now, the only operating cement plants in the state are in Seattle and all limestone used is barged in from Vancouver Island in Canada.

Table 1. Operator and brief description of the activity and geology at major metal mining and exploration projects in Washington in 1998 *(companion to Fig. 2)*

No.	Property	Location	County	Commodities	Company	Activity	Area geology
1	Lamefoot	secs. 4, 8, T37N, R33E	Ferry	Au, Ag	Echo Bay Minerals Co.	Milled 435,163 tons and recovered 89,593 oz of gold from Lamefoot ore	Gold mineralization in massive iron exhalative/replacement mineralization in Permian sedimentary rocks
2	K-2	sec. 20, T39N, R33E	Ferry	Au, Ag	Echo Bay Minerals Co., Kettle River Project	Milled 243,866 tons and recovered 48,979 oz of gold from K-2 ore	Epithermal deposit in Eocene Sanpoil Volcanics
3	Crown Jewel	sec. 24, T40N, R30E	Okanogan	Au, Cu, Ag, Fe	Battle Mountain Gold Corp./Crown Resources Corp.	Permitting still in progress	Gold skarn mineralization in Permian or Triassic metasedimentary rocks adjacent to the Jurassic–Cretaceous(?) Buckhorn Mountain pluton
4	Pend Oreille mine	secs. 10-11, 14-15, T39N, R43E	Pend Oreille	Zn, Pb, Ag, Cd	Cominco American Inc.	Announced ore reserve of 6.5 million tons containing 8.9% zinc and 1.6% lead; initiated EIS to put mine back into production by 2002	Mississippi Valley-type mineralization in the Yellowhead zone of Cambrian–Ordovician Metaline Formation
5	Addy Magnesium mine	secs. 13-14, T33N, R39E	Stevens	Mg	Northwest Alloys, Inc.	Mined 600,000 tons of dolomite for smelting to produce magnesium metal	Cambrian–Ordovician Metaline Formation dolomite

Figure 3. *(above)* Trucks being loaded with ore stockpiled at the portal to the K-2 gold deposit. In 1998, 243,866 tons of ore mined at the deposit was trucked to Echo Bay's mill near the Overlook deposit at Republic.

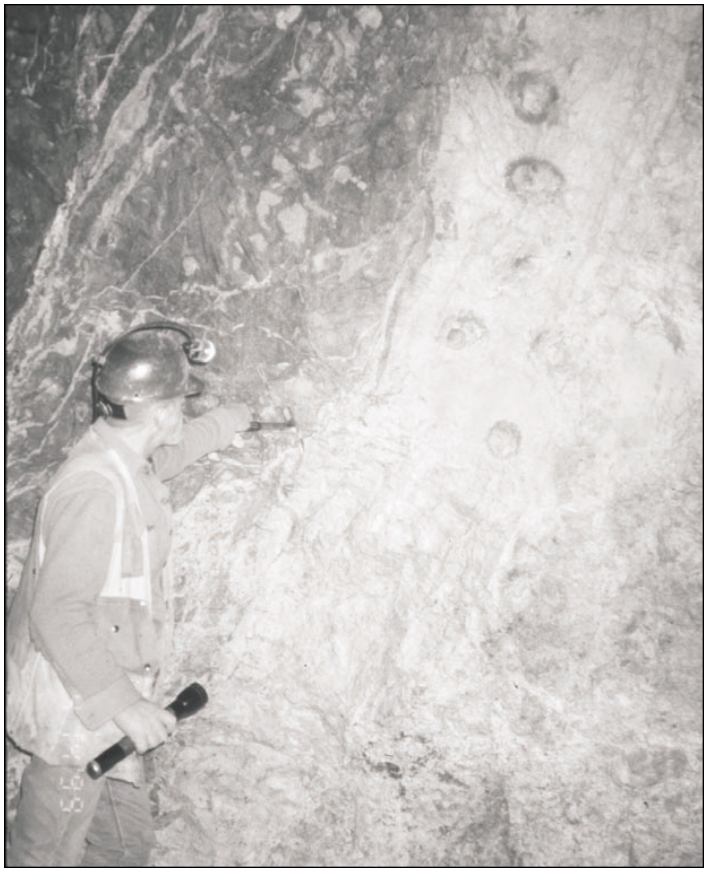

Figure 4. *(right)* Mineralization at K-2 gold deposit near Curlew is an epithermal-type deposit in Eocene volcanic rocks. Here Tom Johnson, Echo Bay mine geologist, points out the vein being mined by underground methods.

Demand for acid-free paper (Bleeck and others, 1993) has resulted in increased demand for finely ground calcium carbonate produced in the central and northeastern parts of the state used in making this paper. Columbia River Carbonates

Table 2. Operator and brief description of exploration and small scale mining operations in 1998

County	Property	Location	Company	Activity
Chelan	Wenatchee Gold Belt	sec. 35, T22N, R20E	Yamana Resources Inc.	Planning to drill in 1999
Ferry	Golden Eagle	sec. 27, T37N, R32E	Newmont Gold Co.	Maintained property
Kittitas	Crazy 8 placer	sec. 17, T23N, R15E	Mike Parish	Seeking permits for placer sampling
Kittitas	Deathtrap mining	sec. 10, T21N, R17E	Robert Sawyer	Exploring
Kittitas	Little Jewel	sec. 27, T21N, R17E		Proposed bulk sampling
Kittitas	Maverick	sec. 30, T21N, R17E	Wally Mieras	Small scale mining
Kittitas	September Morn	sec. 10, T20N, R17E	Ron Kilmer	Bulk sampling, seeking water rights
Kittitas	Sunset Mountain Daisey	sec. 1, T20N, R17E; sec. 6, T20N, R18E; sec. 36, T21N, R17E	Rob Repin	Some drilling, sampling, seeking approval to mine
Kittitas	Three Crosses	secs. 25-26, T23N, R14E	Art Baydo	Maintained property
Kittitas	Williams Creek	secs. 1-2, T20N, R17E	Goodfellow Construction	Reclamation
Okanogan	Aeneas Valley	sec. 8, T35N, R31E	Sunshine Valley Minerals, Inc.	Maintained property
Okanogan	Billy Goat	sec. 15, T38N, R20E	Sunshine Valley Minerals, Inc.	Maintained property
Okanogan	Kelsey	secs. 5-8, T40N, R27E	Wilbur Hallauer	Maintained property
Okanogan	Palmer Mountain	secs. 20-21, 28-29, T39N, R26E	Yamana Resources Inc.	Maintained property following extensive drilling in 1997
Okanogan	Starr Molybdenum	secs. 8, 16, T37N, R26E	Wilbur Hallauer	Maintained property
Skamania	Silver Star	secs. 3-5, 8-9, T3N, R5E	Kinross Gold USA, Inc.	Maintained property
Skamania	Wind River	sec. 9, T5N, R7E	DeLano Wind River Mining Co.	Some mining, continued driving lower adit to intercept vein
Stevens	Iroquois	secs. 1, 19-20, 29-30, T40N, R42E	Mines Management, Inc.	Maintained property
Stevens	Van Stone mine	sec. 33, T38N, R40E	Mano River Resources Inc.	Continued reclamation work
Whatcom	Lone Jack	secs. 22-23, T40N, R9E	Diversified Development Co.	Maintained workings
Whatcom	Minnesota	sec. 2, T37N, R16E	Seattle-St. Louis Mining Co.	Maintained property, renovation, and small scale exploration
Whatcom	New Gold Hill	sec. 30, T37N, R17E	Ed Pariseau	Rehabilitating old workings, sampling
Whatcom	South Pass Nickel	sec. 2, T39N, R4E; sec. 35, T40N, R4E	Consolidated Viscount Resources, Ltd.	Testing feasibility of extracting nickel and scandium from laterite

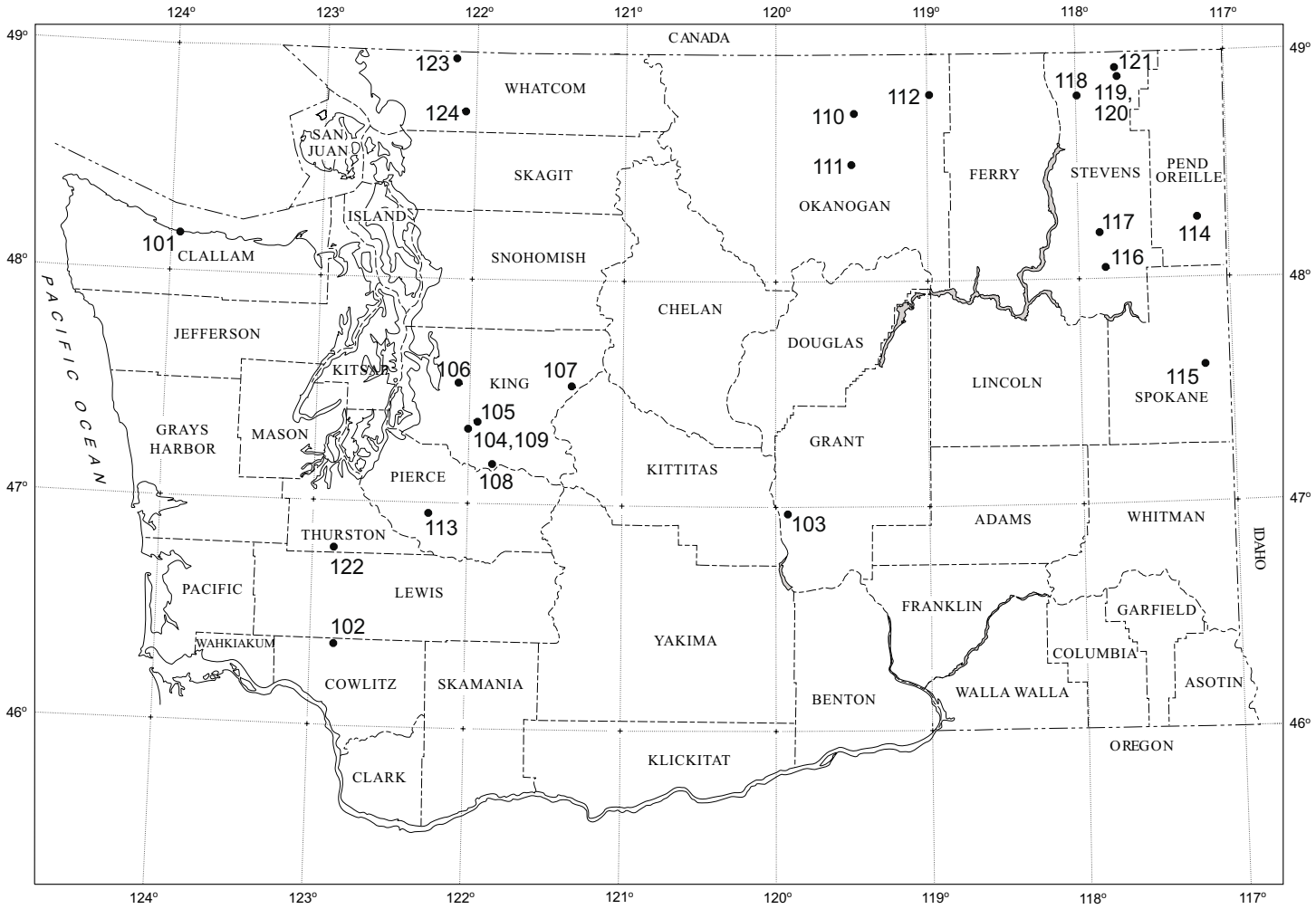

Figure 5. Location of nonmetallic mining operations in Washington in 1998. See Table 3 *(facing page)* for additional details about each of these projects.

continued to produce high-brightness calcium carbonate in 1998 for the paper industry from the Wauconda quarry (Fig. 6, no. 112) in Ferry County. The carbonate is shipped to and processed at its plant in Longview, Cowlitz County.

Several other companies mined carbonate and sold limestone or dolomite as a soil conditioner and (or) as feed lime in Washington in 1998. They include three companies: Pacific Calcium Inc., producing from their Tonasket (Fig. 6, no. 110) and Brown (Fig. 6, no. 111) quarries in Okanogan County; Allied Minerals, Inc., at the Gehrke quarry (Fig. 6, no. 116) in Stevens County; and Northwest Alloys at Addy (Fig. 2, no. 5) in Stevens County, where calcium-magnesium lime is a by-product of magnesium metal production. Carbonates were also mined for other purposes. Northport Limestone Company mined carbonate from its Sherve quarry (Fig. 6, no. 121) in Stevens County and shipped it to Trail, B.C., where it was used as a fluxing agent in smelting. Northwest Marble Products (Fig. 6, no. 118) mined color- and site-specific carbonate products for terrazzo tile and related products.

The Joe Janni (Fig. 6, no. 119) and Janni Limestone (Fig. 6, no. 120) quarries in Stevens County were leased, as in 1997, but there was no active mining in 1998.

The only known active mining of a carbonate deposit in western Washington was at the Maple Falls quarry (Fig. 6, no. 123) in Whatcom County.

Olivine

During 1998, Olivine Corp. mined approximately 55,000 tons of olivine from the Twin Sisters Dunite at the Swen Larsen quarry (Fig. 6, no. 124) in Whatcom County. As in previous years, the majority of their production was shipped as crushed olivine to Unimin Corp, a Belgian company that produces casting sands and other refractory products at Hamilton in Skagit County. The rest of Olivine Corp.'s production was used to produce refractory liners for waste incinerators.

Clays

Much of the clay produced in western Washington was mined by or for Holnam Inc./Lafarge Corp. and Ash Grove Cement Co. to produce cement. Holnam Inc./Lafarge Corp. mines clay from the Twin River quarry (Fig. 6, no. 101), and Ash Grove Cement Co. mined clay from its Castle Rock quarry (Fig. 6, no. 102). A major change in Washington's cement industry occurred when Lafarge Corp. obtained the Holnam Inc. operations in Seattle. Lafarge had previously operated a cement plant at Metaline Falls. The new company assumed control in October.

In addition to coal, Pacific Coast Coal Co. mined clay from the John Henry No. 1 (Fig.64, no. 109) coal mine and shipped it to Ash Grove Cement Co.

Clay used predominantly for bricks and related products was mined by Mutual Materials at the Mica mines (Fig. 6, no. 115) in Spokane County, at the Usk mine (Fig. 6, no. 114) in

Table 3. Operator and brief description of the activity and geology of nonmetallic mining operations in Washington in 1998 *(companion to Fig. 5)*

No.	Property	Location	County	Commodities	Company	Activity	Area geology
101	Twin River quarry	secs. 22-23, T31N, R10W	Clallam	clay	Lafarge Corp./ Holnam Inc.	Mined 82,000 tons for making cement. Lafarge purchased the Holnam cement operations in Seattle and took control in Oct.	Mudstone(?) in three members of the upper Eocene to lower Miocene Twin Rivers Formation
102	Castle Rock quarry	sec. 18, T10N, R1W	Cowlitz	clay	Ash Grove Cement Co.	Mined 18,277 tons of shale/clay	Eocene–Oligocene sedimentary rocks
103	Celite diatomite pits	sec. 3, T17N, R23E; sec. 7, T17N, R24E	Grant	diatomite	Celite Corp.	Mined 115,000 tons of ore and produced 76,000 tons of finished diatomite	Miocene 'Quincy diatomite bed', local sedimentary interbed at base of Priest Rapids Member, Columbia River Basalt Group
104	Ravensdale pit	sec. 1, T21N, R6E	King	silica	Reserve Silica Corp.	Mined and washed 70,000 tons used to manufacture glass	Sandstone of the Eocene Puget Group
105	Elk pit	sec. 34, T22N, R7E	King	shale	Mutual Materials Co.	Mined 12,000 tons of shale (clay) for bricks	Illite- and kaolinite-bearing shales of the Eocene Puget Group
106	Sec. 31 pit	sec. 31, T24N, R6E	King	shale	Mutual Materials Co.	Mined 40,000 tons for producing bricks	Shale of the Eocene Puget Group
107	Spruce claim	secs. 29, 30, T24N, R11E	King	quartz and pyrite crystals	Robert Jackson	Extracting minerals and crystals	Crystals in large, open voids along faulted megabreccia in northern phase granodiorite and tonalite (25 Ma) of the Snoqualmie batholith
108	Superior quarry	sec. 1, T19N, R7E	King	silica	Ash Grove Cement Co.	Mined 130,630 tons of silica	Silica cap in hydrothermally altered Miocene andesites on caldera margin
109	John Henry #1	sec. 12, T21N, R6E	King	clay	Pacific Coast Coal Co.	Mined 48,165 tons of clay and shipped to Ash Grove Cement	Upper middle Eocene silty clay near base of Puget Group as a 30-ft-thick zone above Franklin #9 coal seam
110	Tonasket limestone	sec. 25, T38N, R26E	Okanogan	limestone	Pacific Calcium, Inc.	Mined 11,500 tons of limestone for soil conditioner and feed lime	Metacarbonate rocks in conglomerate-bearing member of Permian Spectacle Formation (Anarchist Group)
111	Brown quarry	sec. 26, T35N, R26E	Okanogan	dolomite	Pacific Calcium, Inc.	Mined 5,336 tons of dolomite used for soil conditioner	Metadolomite member of the Triassic Cave Mountain Formation
112	Wauconda quarry	sec. 13, T38N, R30E	Okanogan	limestone	Columbia River Carbonates	Mined limestone and shipped it to their processing plant near Longview	High-calcium, pre-Tertiary white marble lenses in mica schist, calc-silicate rocks, and hornfels
113	Clay City pit	sec. 30, T17N, R5E	Pierce	clay	Mutual Materials Co.	Mined 8,000 tons to make bricks	Tertiary kaolin-bearing, altered andesite
114	Usk mine	sec. 7, T32N, R44E	Pend Oreille	clay	Mutual Materials Co.	Mined and stockpiled 5,700 tons for making bricks	Holocene lacustrine deposits of clay, silt, and sand
115	Mica mine	sec. 14, T24N, R44E	Spokane	clay	Mutual Materials Co.	Mined and stockpiled 46,000 tons to produce bricks	Lacustrine clay of Miocene Latah Formation overlying saprolitic, pre-Tertiary felsic gneiss.
116	Gehrke quarry	sec. 2, T29N, R39E	Stevens	dolomite	Allied Minerals, Inc.	Mined about 7,000 tons; marketed as a soil conditioner	Isolated pod of Proterozoic Y Stensgar Dolomite(?) (Deer Trail Group)
117	Lane Mountain quarry	secs. 22, 34, T31N, R39E	Stevens	silica	Lane Mountain Silica Co. (*divn* of Hemphill Bros., Inc.)	Mined 315,000 tons, milled at plant near Valley	Cambrian Addy Quartzite
118	Northwest marble mine	sec. 19, T38N, R38E	Stevens	dolomite	Northwest Marble Products Co.	Mined and milled 2,800 tons of color/site-specific aggregate materials for building and industrial applications	Dolomite of Cambrian–Ordovician Metaline Formation; additional colored dolomite products quarried at several other locations
119	Joe Janni limestone	sec. 13, T39N, R39N	Stevens	limestone	Joeseph A. & Jeanne F. Janni	Leased to Columbia River Carbonates; no activity in 1998	Cambrian Maitlen Phyllite, Reeves Limestone Member
120	Janni limestone quarry	sec. 13, T39N, R39E	Stevens	limestone	Peter Janni and Sons	Leased to Columbia River Carbonates; no activity in 1998	Cambrian Maitlen Phyllite, Reeves Limestone Member
121	Sherve quarry	sec. 8, T39N, R40E	Stevens	limestone	Northport Limestone Co. (*divn* of Hemphill Bros., Inc.)	Mined 50,000 tons of fluxing grade limestone and shipped to Cominco smelter at Trail, B.C.	Limestone in upper unit of Cambrian–Ordovician Metaline Formation
122	Bucoda pit	sec. 14, T15N, R2W	Thurston	clay	Mutual Materials Co.	Mined 2,000 tons to make bricks	Glacial clay of Pliocene–Pleistocene Logan Hill Formation overlying silty clay of the Eocene Skookumchuck
123	Maple Falls quarry	secs. 7, 18, T40N, R6E	Whatcom	limestone	Clauson Lime Co.	Mined about 125,000 tons for use as rip rap, aggregate, and landscape rock	Sheared, jointed Lower Pennsylvanian limestone overlain by sheared argillite and underlain by argillite, graywacke, volcanic breccia of Chilliwack Group
124	Swen Larsen quarry	sec. 34, T38N, R6E	Whatcom	olivine	Olivine Corp.	Mined and milled 55,000 tons used for refractory purposes	Mined from Twin Sisters Dunite (outcrop area >36 mi^2) in Whatcom and Skagit Counties

Pend Oreille County, at the Elk pit (Fig. 6, no. 105) and Section 31 pit (Fig. 6, no. 106) in King County, at the Clay City pit (Fig. 5, no. 113) in Pierce County, and from the Bucoda pit (Fig. 6, no. 122) in Thurston County.

Diatomite

Celite Corp. mined and processed 105,000 tons of diatomite at its pits (Fig. 6, no. 103) in Grant County. The company produced 72,000 tons of finished diatomite.

Silica

Lane Mountain Silica Co. (Fig. 6, no. 117) mined 300,000 tons of Addy Quartzite from the Lane Mountain quarry in Stevens County. Following processing, the company shipped 230,000 tons of high-purity quartz, most of which was used to manufacture clear glass bottles and jars.

Reserve Silica Corp. mined 70,000 tons of quartz-rich Puget Group sands from the Ravensdale pit in King County (Fig. 6, no. 104). Most of Reserve's production is used for the manufacture of colored bottle glass.

Ash Grove Cement Co. mined nearly 130,000 tons of silica from its Superior quarry (Fig. 6, no. 108) in King County; the company uses the silica for making cement.

INDUSTRIAL MINERAL INDUSTRY ACTIVITIES

Value of construction sand and gravel production in 1997, the single most valuable nonfuel mineral commodity in Washington, was over $180 million, an $18 million increase from 1996. The value of crushed stone used for construction in 1997 was over $92 million. Together these industrial mineral commodities, construction sand and gravel and construction stone, accounted for approximately 49 percent of the $555,430 million total value of nonfuel mineral production for Washington in 1997. Despite the low unit value of construction materials, their sheer volume is what makes them the overall value leader in Washington. Two major users of construction materials are the building and road construction industries.

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BOOK REVIEW: Ginkgo Petrified Forest

by Mark Orsen, 1998
Available by mail from the publisher, Ginkgo Gem Shop
PO Box 1404; Vantage, WA 98950
paperback, 7 x 10 in., 28 p.
$9.95 + $0.77 tax + $1.50 shipping = $12.22

Ginkgo Petrified Forest State Park and Interpretive Center is located at Vantage, in central Washington, where Interstate Highway 90 crosses the Columbia River. In this booklet, Mark Orsen, a freelance historian, photographer, and writer currently employed by the Boeing Company as a graphic illustrator, describes the natural history of the Park. The book was four years in the making, and the time and care taken with it show; the book is beautifully done.

The geologic, geographic, climatic, and biologic aspects of the natural history of the area are imaginatively described in a carefully written and edited text that is intended for a nontechnical audience but covers technical matters in a fully understandable way. A short glossary and selected bibliography provide avenues for further study. Careful reading exposes a few errors, but none that detract measurably from the story.

The text is laudable, but the real beauty of this book is in the photos. The book is printed on heavy, coated, glossy paper, which allowed the color photos to print beautifully, and there is at least one photo on every page except for the back cover, which is a colored map.

As you would expect, there are more photos of petrified wood than anything else, but the geographic and geologic settings are also well illustrated. The most striking photos of petrified wood are of rounds, which are cross sections of logs. The author uses photos in the usual way—to illustrate things covered in the text—and also as a screened background for text and other photos. For example, a panoramic view of basalt cliffs along the Columbia River appears at the bottom of facing pages, and instead of stopping where the text begins, the sky extends up the pages to form a blue-gray background for text. The effect is very attractive and gives visual variation to many pairs of facing pages. Ginkgo leaves, sky, trees, microscopic views of the cellular structure of petrified wood, and petrified wood chips littering the ground are used as backgrounds. Photo and figure captions are printed in a different font from the main text and with a colored background, so they are easy to read.

Even though the book is short, it conveys a lot of information. It leaves you with the feeling that you know all about the Ginkgo Petrified Forest. Each pair of facing pages describes a different aspect of the Forest. Topics covered include the discovery of ginkgo logs in the area; formation of the State park; natural history of the Order Ginkgoales; how flood basalt eruptions behave; the number, ages, names, and characteristics of some of the basalt flows in the Vantage area; species of petrified trees and notes on modern relatives; the petrification process; how the kinds, sizes, and life stories of individual trees can be read from their petrified remains; how the climate of the site has changed, making the area almost completely treeless today; how the erosion of the massive Spokane (glacial Lake Missoula or Bretz) floods sculpted the area and exposed the petrified forest; and the petrified forest as it appears today.

The carefully crafted text and beautiful supporting photographs weave these subjects together smoothly, create a rich set of contexts in which to view, in the mind's eye, the natural history of the area, and leave the reader with a deeper appreciation of the events that created the Ginkgo Petrified Forest.

J. Eric Schuster

Washington's Coal Industry—1998

Henry W. Schasse
Washington Division of Geology and Earth Resources
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In 1998, Washington's two producing coal mines—the Centralia mine in north-central Lewis County and the John Henry No. 1 mine in south-central King County—together produced 4,638,558 short clean tons of coal. Total production was up by 142,708 tons from 1997 levels.

The state's largest coal mine, the Centralia Coal Mine, is operated by the Centralia Mining Company, a division of PacifiCorp. The mine is located 5 mi northeast of the city of Centralia (Fig. 1). The mine's sole customer, the Centralia Steam Plant, is located about a mile from the mine.

The mine completed its 28th year of production in 1998, producing 4,622,315 short tons of subbituminous coal, 194,665 tons more than in 1997. The mine's average annual production over the past 5 years has been 4.6 million tons per year; average annual production over the life of the mine is 4.3 million tons per year.

Coal production in 1998 came from four open pits. Coalbeds mined were two splits of the Big Dirty, one split of the Little Dirty, Upper and Lower Thompson, and two splits of the Smith. These coalbeds are part of the Skookumchuck Formation, made up of nearshore marine and nonmarine sedimentary rocks. The Skookumchuck is the upper formation of the Eocene Puget Group.

Washington's other producing coal mine, the John Henry No. 1, is located 2 mi northeast of the town of Black Diamond (Fig. 1). The mine is operated by the Pacific Coast Coal Company (PCCC), which completed its 12th full year of production in 1998. The mine produced only 16,243 short tons of bituminous coal in 1998, a reduction of 51,957 from its 1997 production. This is a significant drop from previous production two years ago of about 105,000 tons. The dismal production is the result of a large landslide in the mine in January of 1997 that significantly affected the mine's ability to supply its then current market. The attendant loss of local industrial customers and the dramatic downturn in the Asian economy, resulting in the loss of South Korean customers, occurred at about the same time. Representatives at the mine say they are hoping to reclaim some of the customers lost over the past two years.

Nearly all the coal sold by PCCC in 1998 (93% of sales) went to fuel Puget Sound lime kilns. Six percent was sold to public institutions for space heating. Less than one percent was sold to private institutions and residential customers for space heating.

In 1998, PCCC mined coal from two pits. At Pit no. 1, it mined coal from the Franklin Nos. 7, 8, and 9 coalbeds. Coal in pit no. 2 was mined from the Franklin 810 and No. 12 coalbeds. The Franklin coalbeds are stratigraphically near the base of the undivided Eocene Puget Group in nonmarine deltaic sedimentary rocks.

PCCC also continues to mine a 30 ft-thick clay bed, lying stratigraphically between the Franklin Nos. 9 and 10 coalbeds. In 1998, the company mined 48,555 short tons of clay in the mine. The clay is blended with high alumina clay from another source for the manufacture of portland cement. ■

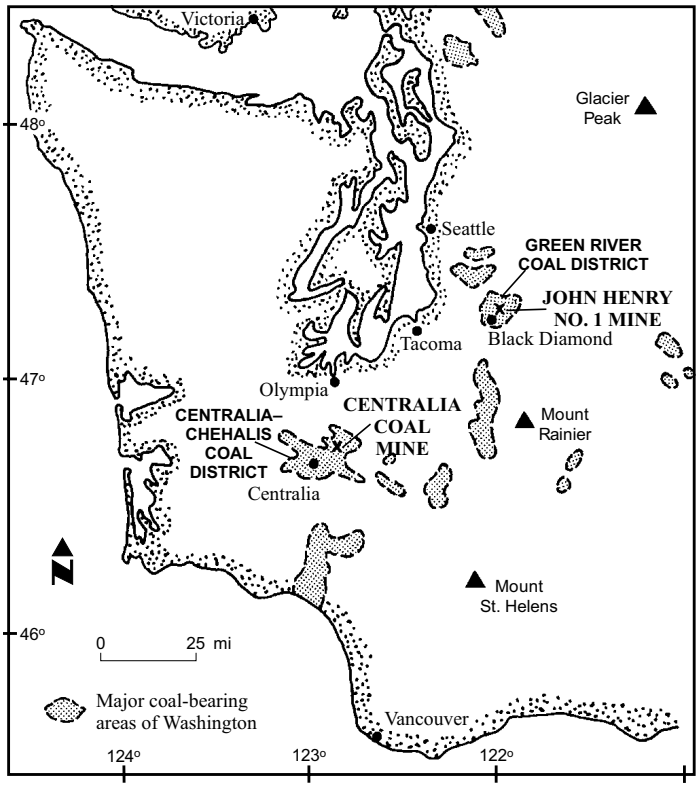

Figure 1. Coal-producing areas and districts, western Washington.

EARTH CONNECTIONS: Educational Resources for Teaching Earth Science

The new column *Earth Connections* will make its debut in the next issue of *Washington Geology* to help parents, homeschoolers, and teachers with K–12 geoscience education. Our aim is to provide suggestions or sources for low-cost or free, easy-to-use materials, lessons, activities, or field trips.

We welcome suggestions for topics and content. What materials do you want? What kind of help do you need?

Send letters to:

Library – Earth Connections
Division of Geology & Earth Resources
PO Box 47007
Olympia, WA 98504-7007

or contact:

connie.manson@wadnr.gov
lee.walkling@wadnr.gov
(360) 902-1472
(360) 902-1785 *fax*

A reminder: the Division's Geology Library, a fantastic source of geological information about Washington, is open to all, Monday through Friday, 8:00 a.m. to 4:30 p.m. Materials cannot be checked out; it is a reference-only library.

The H. P. Scheel Family—A History in Stone

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Credited with saying "The bounty of the Earth is there to reap—take advantage of it!", H. P. Scheel was a prominent Washington businessman and promoter in the early 1900s. Scheel preferred to be called by his initials 'H.P.' and gained the nickname 'Horse Power' for his legendary ambition. H.P. and his family (Fig. 1) became well known as quarriers, stonecutters, and prospectors. Together, they contributed much to the building stone, monumental stone, and jetty rock industries in the Pacific Northwest. H.P.'s youngest son, Lorenz 'Larry' Scheel, 91, passed away March 10, 1999, marking the end of an era. This is the story of the Scheel family and the industries they influenced.

Figure 1. The Scheel family at their Tacoma mansion on Prospect Hill. Back row: Fran, Walt, Karl, Larry, Heinie, Dorothy (Doe). Front row: Louise, H.P., Margaret, Frances. Picture taken at the time of Fran Scheel's wedding on June 28, 1916. The stone circle (left side) has 'H. P. Scheel' cut into it. Photo courtesy of Scott McArthur.

Born into a stonecutting family, Hans Peter Scheel (1866–1940) immigrated in 1882 with his father Hans Hinrich Scheel (1834–1894) from Germany to Iowa. After moving to Portland, Ore., in 1887, H.P. met his future wife Franziska 'Frances' Louisa Christina Stein (1870–1956). They were married in Tacoma in 1889.

In 1890, H.P. was a partner in a Tacoma stonecutting business called Simpson & Scheel. Later, during the 1893 economic panic, he worked as a stonecutter in the Tenino area. H.P. walked there from Olympia (about 15 miles), staying the week for work and walking back home for the weekends.

Moving to Spokane in 1896, H.P. became a partner with Frank Swanson (1862–1930) in the Washington Monumental Works, and in 1901, incorporated the business as the Washington Monumental and Cut Stone Company. This company became a significant building and monument stone quarrier and fabricator for the Inland Empire. (It was sold by Swanson's grandson Byron 'Bud' Swanson (b. 1916) to Tresko Monument Company, also of Spokane, in 1971.)

Employing up to 30 men in 1902, the partnership worked local granite, marble (dolomite), and basalt, and imported stone for monuments and structures. At the time, Spokane was losing notable pioneers, and large tombstones were in demand. Additionally, Spokane was a growing regional economic and railroad hub. Spokane was a major supplier to the mines in the nearby Coeur d'Alene, Idaho, and Colville mining districts. Many men died in these mines, creating an ongoing need for tombstones. The partnership also furnished stone for the Spokane mansion (1899) of mining mogul Patrick 'Patsy' Clark (1850–1915), Spokane buildings like the Carnegie Library (1905), and memorials for the Grand Army of the Republic (Union Army, Civil War) in Spokane (1906) and Pomeroy (1905) (Fig. 2).

Figure 2. H. P. Scheel (right) and an unidentified stone carver using a compressed air hammer in Spokane to finish the statue of a Union soldier that crowned the Grand Army of the Republic memorial in Pomeroy (ca. 1905). The statue was later damaged and removed from its pedestal. Photo courtesy of Byron Swanson.

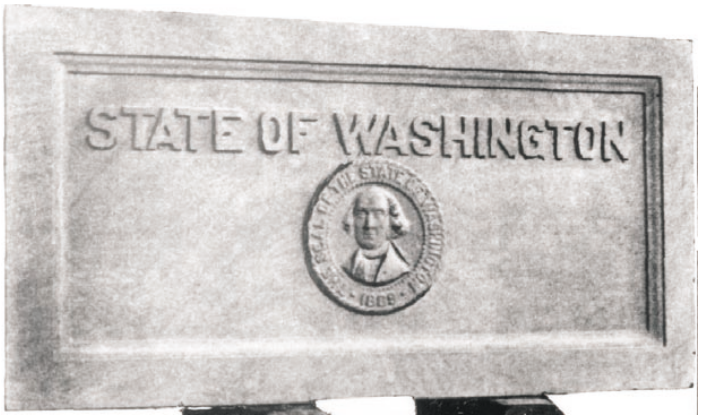


Figure 3. Tenino sandstone from Hercules Quarry No. 1 carved with the State Seal to represent the State of Washington at the Washington Monument in Washington, D.C. (1914). Photo courtesy of South Thurston County Historical Society, Tenino, Wash.

With business quickly growing, H.P. went from stonecutting to promoting sales for the company. Typically, he kept track of obituaries in the newspaper and, after an appropriate time, queried survivors about possible monument orders. He could quickly figure in his head all the mathematics required for orders and other business deals. H.P. traveled Washington, Oregon, Idaho, and Montana by horse and buggy, and later by car and rail to promote his products. He spent much time away from home.

In 1902, H.P. founded the Hercules Sandstone Company in Tenino with Ritzville banker Claus Clodius (1871–19??) and quarryman William McArthur (1866–1940). McArthur was responsible for hiring many stonecutters and quarrymen from Scotland for the Hercules quarries. The Hercules company quickly became successful despite competition from the well-established Tenino Sandstone Company. The businesses were located on opposite ends of town, working similar outcrops of sandstone from the Eocene McIntosh Formation (Snavely and others, 1958).

In 1906, the great San Francisco earthquake created a tremendous demand for materials to rebuild that city. By chance, San Francisco's Calvary Presbyterian Church was one of the limited number of buildings to survive the earthquake and fire that followed. It was made of Tenino sandstone from the Tenino Sandstone Company. Since the Hercules company also quarried Tenino sandstone, orders grew rapidly to meet demand. H.P. sold his Spokane business interests to focus on his new company. When he sent employees to San Francisco to oversee the new stonework, his sons Karl (1891–1961) and Walt (1892–1984) went along to apprentice in San Francisco stone shops. Both sons returned to Tenino to add their expertise to the family business.

The Hercules Sandstone Company grew quickly and eventually became one of the largest stone companies on the West Coast. It supplied dimension stone for many buildings in Seattle, Tacoma, Portland, Spokane, and San Francisco. (For a list of these buildings, see Knoblach, 1994.) In 1914, the Hercules company carved the stone that represented Washington State at the Washington Monument in Washington, D.C. (Fig. 3). It is now displayed in the monument stairwell.

The Hercules Sandstone Company operated six quarries in its heyday. Opened in 1903 on Lemon Hill southwest of Tenino, Hercules Quarry No. 1 primarily supplied building stone (Figs. 4, 5). The stone's soft mineral composition made it less

Figure 4. A channeler cuts grooves in the stone (top right) to make blocks at Hercules Quarry No. 1. Two stone blocks are being lowered to the mill area from the quarry. They demonstrate the two different methods for lifting the blocks. Heavy chains were wrapped around the largest stones (left block), which could be removed through the notch on top of the rail car (see front right of photo). Smaller stones (right block) had 'dog holes' and could be picked up by hooks. Note the 4-inch slabs cut as dimensional stock (front). These were placed vertically until an order was received and were then laid flat to be cut individually to size. Photo ca. 1909 courtesy Special Collections Division, University of Washington Libraries, negative no. 14656. Photo by Asahel Curtis.

expensive and quicker to cut and carve, allowing competitive pricing at a profit. Its workability is illustrated by the rate at which it can be cut by a modern, 9-foot circular diamond saw: Wilkeson sandstone is cut in 1-inch increments and Tenino sandstone in 2½-inch increments. Although it was described as 'butter' by competing quarriers, Tenino sandstone has confirmed its relative durability in century-old buildings.

At Seattle's 1909 Alaska–Yukon–Pacific Exposition, the Hercules company featured a promotional display of a suspended, freshly quarried and cut stone slab (measuring 8 feet 4 inches by 4 feet 6 inches by only 1 inch thick). The slab was from the No. 1 quarry. By the end of the Exposition, the slab had elastically bowed eight inches due to gravity and plastic deformation without visible signs of cracking. Freshly quarried sedimentary rock is temporarily softer and more flexible than aged quarried stone, because its stored elastic potential energy is being released from compression within the outcrop (Winkler, 1994). The company was awarded a Silver Cup for its 'flexible sandstone'. Thereafter, a picture of this slab (Fig. 6) highlighted the event on the back of the company's stationary. In 1904, Hercules' competitor, the Tenino Sandstone

Company, also had received a Silver Metal for Tenino sandstone at the Universal Exposition in St. Louis, Mo.

By about 1910, sales of building stone started to wane because of competing building materials. Local concrete, brick, and terra cotta had improved in quality and could be produced more quickly and cheaply than stone. Architectural styles also had changed, favoring taller buildings using structural steel and the new materials (Knoblach, 1993). A major competitor, the Chuckanut sandstone quarry in Bellingham, which quarried sandstone in the Eocene Chuckanut Formation, permanently closed in 1913 after 57 years of production.

In search of more opportunities, H.P. sought and won a major government contract for jetty rock at Grays Harbor (U.S. Army Corps of Engineers Seattle District Office, 1912–1927). He retained the No. 1 quarry for building stone production and acquired the Eureka quarry in 1911. Also in an outcrop of Tenino sandstone, the Eureka was renamed Hercules Quarry No. 2 (Fig. 7). Located just east of Tenino, the Eureka quarry previously produced stone for the Northern Pacific Railway warehouses in Tacoma and for other structures.

A famous event occurred at the No. 2 quarry on Feb. 17, 1912. It was called the 'Big Blast'. Two three-foot diameter tunnels called 'coyote holes', with a combined length of 1,400 feet, were cut into the base of the outcrop (Fig. 8). The tunnels were carefully backfilled with two train car loads of explosives (43,100 pounds of black powder and 1,200 pounds of 60 percent dynamite).

H.P. saw the blast as a wonderful opportunity for publicity. Tenino residents turned out, officials arrived from Washington and Oregon, and camera crews came from Hollywood to film the explosion, probably for newsreels at cinemas (Roberts, 1912). Tenino residents were asked to secure fragile possessions in their homes against the expected ground motion.

The 'Big Blast' was one of the largest single detonations in Washington history (Fig. 9)—and it was larger than expected (an estimated 500,000 ton rockfall). It buried the quarry's rail spur with boulders (Fig. 10), damaged nearby quarry buildings with flying rock (Fig. 11), and pelted onlookers with rock fragments despite their 'safe' distant viewing positions. The cost of the event, including repairing the damage, totaled $20,000. However there was an additional cost—the huge concussion pulverized as much as 40 percent of the rockfall, making much of the rock either too small or too incompetent due to microfracturing for its intended purpose at the jetty.

Figure 5. A stone carver shows off a building pediment at the Hercules Quarry No. 1 (ca. 1907). William McArthur is second from left. Photo courtesy of South Thurston Historical Society, Tenino, Wash.

Figure 6. The cut slab of 'flexible' Tenino sandstone from the No. 1 quarry on its way to Seattle's 1909 Alaska–Yukon–Pacific Exhibition. A stone chisel was used here to notch the sides of the slab so it could be lifted without the rock slipping. This promotional photo was later printed on the back of Hercules Sandstone Company stationary. Left to right: H. P. Scheel, William McArthur, J. B. Jonas, Johnny Jonas, Andrew McArthur, I. D. Jonas. Photo courtesy of Scott McArthur.

By 1913, the Hercules company had over 100 employees. Scheel and McArthur acquired other quarries, including one of the trade-named Wilkeson sandstone quarries located near Wilkeson (subarkosic sandstone of the Eocene Carbonado Formation); another quarry, possibly in the Tenino region (its location and stone type has been forgotten); and the trade-named Mother of Pearl[1] (Ymir Pearl) granite quarry near Ymir, B.C. (a pulaskite in a syenite plug of the middle Eocene Coryell intrusion) (British Columbia Ministry of Energy and Mines,

[1] Abundant biotite in this stone resulted in excessive wear, particularly along exposed edges and in fine detailing on monuments (such as the engraved plaques of the War Memorial, Nelson, B.C., ca. 1919). However, polished cut surfaces have weathered well in the base courses and entryways of the Hartford Building (1929), Seattle; the Bank of California (1929), Tacoma; and the Security Building (1927), Olympia.

1999). These quarries were respectively named Hercules Quarry No. 3, 4, and 5.

Additionally, H.P. acquired the Giles quarry, later known as the Silver Lake granite quarry, at Medical Lake (granodiorite possibly related to the Eocene(?) intrusives of the Silver Point quartz monzonite) (Joseph, 1990); the Dorset granite quarry, later renamed the Little Spokane granite quarry, north of Spokane (biotite granite similar to the Cretaceous Mount Spokane Granite) (Joseph, 1990); and a quarry in the trade-named Index granite near Index (granodiorite of the Oligocene Index batholith—some evidence has indicated that the No. 4 quarry was at Index). H.P. also dealt in many other types of stone from different quarriers.

While fishing on the Skookumchuck River, H.P.'s son Walt discovered a granite outcrop about 9 miles southeast of Tenino (gabbro porphyritic dikes and sills, late Oligocene to possibly Miocene) (Schasse, 1978). Granite is important for its durability, and the relative scarcity of this competent rock in southwest Washington increased its potential value. It also surpassed the comparatively marginal quality and size of rock offered by most area competitors. To gain approval for use of this rock at Grays Harbor jetty, Walt guided officials from the bank and Army Corps of Engineers to the remote site, carrying them on his back over the meanders of the Skookumchuck River so they could keep dry.

Figure 7. Hercules Quarry No. 2 before the 'Big Blast'. Rough blocks of rock are being loaded onto rail cars bound for Grays Harbor jetty (1911). Note the channeled quarry face remaining from building stone quarrying at the site in the 1890s. Photo by D. Kinsey, courtesy of Scott McArthur.

After winning another jetty contract for this rock, H.P. began an ambitious push to quickly build a rail spur through the wilderness. The site was named Hercules Quarry No. 6 (Fig. 12 and cover). As the summer jetty work season approached, the Hercules Sandstone Company hired over 300 additional men to open the quarry. Four to five camps were built for the laborers. Working around the clock, they completed the 12-mile rail spur to the quarry in just 6 weeks. The quarry shipped its first rock on June 28, 1916, after more than $200,000 was spent on spur development. Soon, shipments to the jetty rose to 1,600 tons of rock daily (U.S. Army Corps of Engineers Seattle District Office, 1912–1927).

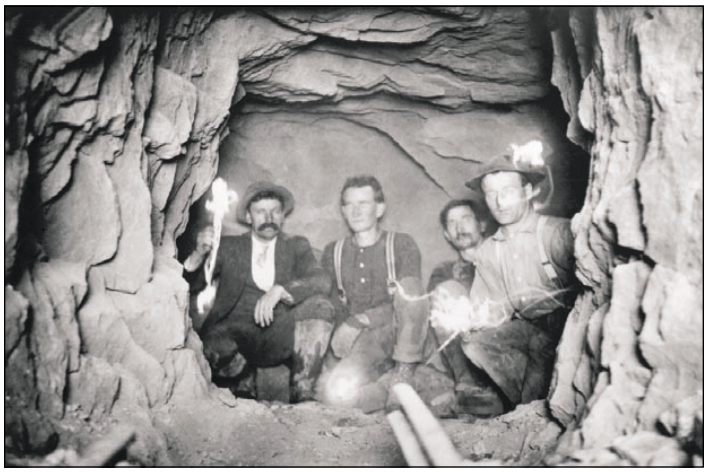


Figure 8. William McArthur (left) and other quarrymen and powdermen pose in the coyote hole before the 'Big Blast' (1912). Photo courtesy of South Thurston County Historical Society, Tenino, Wash.

H.P. subsequently became a friend of railroad baron Samuel Hill (1857–1931), who profited from the heavy rail shipments by the Hercules company. Hill gave H.P. a pass for free travel anywhere on his railroad. H.P. used the pass to travel widely to promote his company.

Scheel became involved with other ventures. Needing water for his businesses and employees, Scheel helped to improve Tenino's city water supply. He also was involved in the unsuccessful wildcat drilling for oil in the Tenino area around 1914–1915 (Fig. 13). Scheel was a founder of the Paraffin Oil Company (Tenino) and the Western Coke and Coal Company (Seattle), and was an investor in the Washington–Oregon Oil Company (Tenino), Spokane Marble Company (Spokane), American Onyx and Marble Company (Spokane), Royal Climar Group

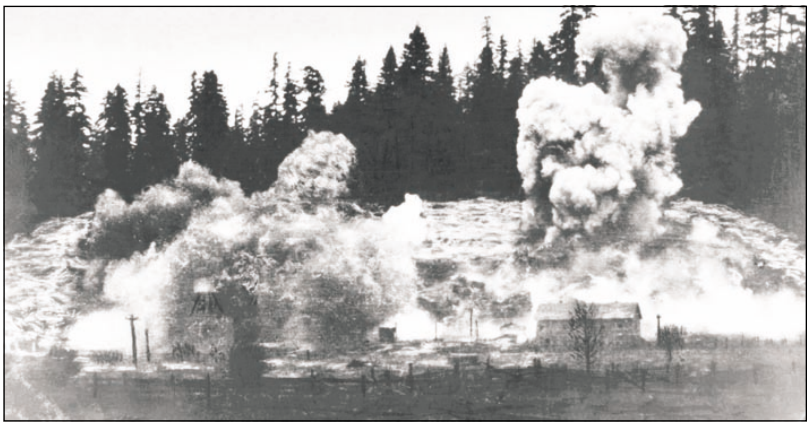


Figure 9. The explosion from the 'Big Blast' at Hercules Quarry No. 2, east of Tenino (1912). Very large charges were common during this time. Note the buildings in the foreground. Photo courtesy of Art Dwelley.

Figure 10. Rail spur at Hercules Quarry No. 2 buried by boulders from the 'Big Blast' (1912). Note how the rail bed and rails were impacted by the boulders. The people are unidentified, except for the waterboy, Andrew 'Punch' McArthur. Photo courtesy of Scott McArthur.

Figure 11. The mill building damaged by flying boulders at Hercules Quarry No. 2 after the 'Big Blast' (1912). The structure on the upper right is the water tower for making steam by trains at the quarry. People are unidentified. Special Collections Division, University of Washington Libraries, negative no. 15081.

Mining Company (Spokane), and the State Bank of Tenino (Tenino). H.P. also owned the Oasis Hotel in Tenino (renaming it the Frances Hotel, after his wife).

Additionally, H.P. was very interested in inventions, at least as a promoter and investor. However, his partner, William McArthur, was the one with the inventing skills. Some inventions were successful—such as a method for creating illuminating gas out of coal (Fig. 14). (McArthur had interests in local subbituminous coal mines near Tono.) McArthur had the first gas light in Tenino through this method. The invention sold for $50,000 (equivalent to $850,000 in 1999). However, other inventions were questionable. One was an 'Inhalatorium' that operated in Tenino around 1915. It was a telephone-booth-sized spa where the patient sat and breathed piped-in coal gas as an aid to curing ills such as emphysema.

Figure 12. Hercules Quarry No. 6 (in the distance) and its rail spur (in the foreground). The quarry is now underwater behind Skookumchuck Dam. Photo courtesy of South Thurston County Historical Society, Tenino, Wash.

Under H.P.'s leadership and with McArthur's inventing skills, the Hercules company developed a process to protect Tenino sandstone against weathering discoloration. Deposited on an anoxic delta front, Tenino sandstone comes in two colors: Tenino 'blue' (a dark gray) and its oxidized counterpart, Tenino 'buff' (brown). Although color variations increased its aesthetic appeal, weathering sometimes ruined the architectural color schemes specifically designed for some buildings. To stop the oxidation, the exterior surfaces were painted with phosphoric acid. The result was a light-gray color that remained relatively stable over time. Since only the exterior surfaces were etched, the interior structural characteristics of the stone remained intact. Perhaps the first building to receive this treatment was the Federal Building (1915) at The Dalles, Ore. Conversely, a strong base will turn untreated Tenino 'blue' sandstone into 'buff'.[1]

Work on the jetty proved to be very difficult for all parties. The Hercules company struggled to meet shipment quotas. Between 1911 and 1916, Pacific Ocean storms periodically

[1] A unique opportunity to measure the weathering rate of Tenino sandstone occurred after the renewal of quarrying at the Hercules No. 1 quarry in 1994 and 1995. Blocks from the abandoned and unetched 'blue' sandstone quarry bed were quarried over an 18-month period by a Ditch Witch with a six-foot diameter cutting wheel (note weathering along one of the blocks in fig. 1 of Gulick, 1995). Last quarried for a limited time around 1940, most of the remaining stone had been weathering since the early to mid-1930s.

A total of 737 weathering depth measurements were taken every six inches along the blocks quarried and along associated quarried cuts near the high wall at the site. Measurements were rounded to the nearest eighth of an inch. The blocks were separated by about six inches by the channeled-cut of the Ditch Witch wheel into the stone. Measurements, however, were not taken from the most recently worked (ca. 1940) areas of the quarry. *(continued on facing page)*

Figure 13. Washington–Oregon Oil Co. wildcat oil well above the No. 2 quarry near Tenino (1915). The people are unidentified. Photo courtesy of South Thurston County Historical Society, Tenino, Wash.

washed away thousands of feet of jetty and the accompanying rail trestle used to place rock (Fig. 15). Floods in 1916 washed out a bridge on the rail line to the No. 6 quarry. Accidents, the lack of rail cars to ship rock, and inadequate mooring space to transfer rock onto barges in Aberdeen caused additional delays. Problems also hampered rock production at the quarries—including poor rock quality from over-blasting at Quarry No. 2 and blasting limitations within the narrow gorge at Quarry No. 6. During a period of tight funding for the jetty, H.P. continued rock deliveries to keep his employees working. However in 1912, he temporarily shut down operations until the government paid over $120,000 owed to Hercules (U.S. Army Corps of Engineers Seattle District Office, 1912–1927).

Unfortunately, U.S. involvement in World War I suddenly halted the contracted rock work on Grays Harbor jetty. In production for only four months, the idle No. 6 quarry could not repay the tremendous expense for its development, and the war economy tied up funds desperately needed for the ailing business. With about $112,000 in liabilities, the Hercules Sandstone Company failed in 1917 (U.S. Army Corps of Engineers Seattle District Office, 1912–1927).

The Scheel family lost everything except an undeveloped piece of land a mile north of Tenino. A financial statement made for H.P. a year before the failure listed assets after liabilities of over $700,000 ($11.4 million in 1999 dollars, based on the Consumer Price Index). All assets of the company were sold. The Scheel's had to leave their $20,000 Prospect Hill mansion in Tacoma and lay off their house staff to pay their remaining debts. Their Cadillac car—the first on Prospect Hill—also was lost. Their youngest children were transferred from schools in Tacoma back to Tenino.

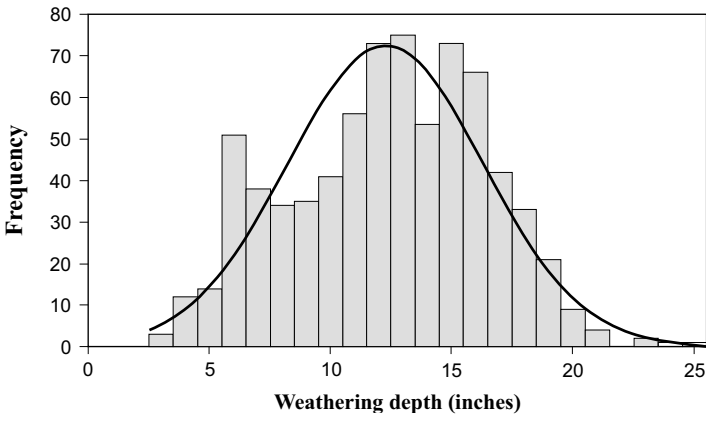
The Scheel's temporarily returned to the Frances Hotel (under new ownership) until they had developed their remaining land for farming and built their new home. As Scheel and his older sons worked away from the farm, much of the credit for holding the family together during this time was due to H.P.'s wife and elder daughters Fran (1896–1998) and Doe (1902–1992). The youngest children, Larry (1908–1999), Louise (1912–1999), and Margaret (b. 1913) remained on the farm.

Until 1938, Scheel and McArthur attempted unsuccessfully to recover money from the U.S. Government. They felt that a broken government contract for jetty work ruined the Hercules Sandstone Company. Despite their issues about the contract, there is no doubt that Scheel and McArthur were victims of circumstance because of the war. Prominent businessmen from the Puget Sound area provided letters of support to the government on behalf of Scheel, vouching for his honesty and integrity as a businessman. However, the appeals were refused with-

Statistical analysis showed weathering depths compiled into a bimodal histogram that ranged from 3¼ inches to 24½ inches. The resulting 95 percent confidence interval for the mean was (11.9606, 12.5475). The median was 12½ inches, and the standard deviation was 4.0582 inches. The bimodal histogram highlights the major influences on weathering at the site. The most protected portions of the site contained the least amount of weathering. These areas occurred along the base of the quarry highwall in locations previously covered by a mushroom farm building. Constructed after quarrying had ceased, the structure was later torn down after operating for an unknown number of years.

Generally greater weathering depths were observed outside the footprint of the mushroom structure. Additionally, pronounced weathering depths corresponded to another factor: fractures or joints became conduits for water to oxidize the stone at depth. This observation indicated that localized variability in porosity also may influence percolation and weathering depth, but not to as great an extent as fractures and joints.

The horizontal quarried surface was askew to the bedding, which dips to the southwest at about 20 degrees. The surface also had areas of slightly higher and lower elevations that allowed localized water pooling or watershed areas that contained minor, but varying amounts of surface sediment and vegetation. These factors may have influenced water percolation and weathering rates. The results from the data should be considered estimates because modern quarrying was not oriented with the direction of previous quarrying. This created an approximate 60-year time period for weathering exposure at the site.



out compensation upon the government interpretation of the contract (U.S. Army Corps of Engineers Seattle District Office, 1912–1927).

The Scheel family slowly recovered after great hardship, but never regained the prosperity of the Hercules days. The Hercules office building was disassembled block by block from its location at the No. 1 quarry (Fig. 16) and rebuilt in downtown Tenino. It was moved by H.P. and his son Walt. It is currently used as the Tenino City Hall. Walt said it was the only structure that he built twice. H.P. searched in vain for another outcrop of stone on his remaining land and later opened a gravel pit near Tenino.

H.P.'s son Karl modified his stonedrafting skills and became a naval architect in Seattle, San Diego, and Los Angeles. He converted surplus war submarine chasers into luxury yachts. Karl's 110-foot yacht, *Tenino* (originally *USNSC 294*, ca. 1917), was used as a charter along the West Coast. It once hosted a Hollywood movie star (possibly John Barrymore) and his friends. Larry Scheel, a crew member on the yacht in the early 1920s, was shocked when the female guests blatantly smoked cigarettes.

Walt Scheel had apprenticed at the McGilvray Stone Company in San Francisco and later was the foreman and a stonecutter for the Hercules Sandstone Company until its closure 1917. Turning to carpentry, he helped build the lumber town of Vail in Thurston County with his brother Larry, constructed housing for the building of Cushman Dam, and also built homes around Tenino.

Heinie or Hans Scheel (1900–1976) became a noted Sedro-Woolley prospector, dealing in many different types of stone. Before much of the North Cascades were designated park and wilderness areas, Heinie parachuted supplies into the back country and later sought the supplies on foot before he prospected and packed out samples. In Whatcom, Skagit, Island, Chelan, and Grant Counties and probably some others, Heinie opened soapstone, silica, travertine, andesite, basalt, gneiss, slate, jade, chert, and beach stone quarries. He was the first to quarry the Twin Sisters Dunite, the largest dunite deposit in the Western Hemisphere, near Twin Sisters Mountain. The deposit covers over 36 square miles (Valentine and Huntting, 1960; Moen, 1967; Corlis Smith, pers. correspondence, 1999). The dunite is an uncommon massive olivine-rich rock used for refractory purposes.

Heinie was an inventor too. He invented the 'Scheel Process' for converting sewage into fertilizer and sold it to a firm in Japan. He also invented a method for creating durable pulpstones (for grinding timber into pulp) using silica gravel spun to the perimeter of a quickly rotating mold before it was cemented with concrete. Using this method in 1928, he incorporated the H. P. Scheel Eversharp Pulp-Burr Company to market the pulpstones (Fig. 17). His father's photograph was featured on the stock certificate. Later Heinie owned the Scheel Stone Company (Seattle) and Western Mineral Company (Seattle). Heinie's quarries also provided silica for glass making in Seat-

Figure 14. William McArthur (left) and his brother Robert (right) in a Tenino laboratory (ca. 1912) demonstrating William's invention to convert coal in a furnace into illuminating gas. Note that the furnace is built of cut sandstone. The patent sold for $50,000. They used some of the money for a trip home to Scotland and invested the balance in Quarry No. 6. Photo courtesy of Doris Sterling.

Figure 15. Construction of the Grays Harbor north jetty March 5, 1937. The rock was carried out on the jetty trestle by rail car and dropped over the side. A similar method was used for jetty construction during the 1910s. The jetty was finished with rock from the Columbia quarry, located at the top of the Skoocumchuck River valley in the same intrusion as the No. 6 quarry, and rock from the Fisher quarry in the Boring Lava (late Pliocene to early Pleistocene basalt-andesite) near Camas, Wash. (Phillips, 1987). Rock from the Fisher quarry was used on jetties from Eureka, Calif., to Alaska. Photo courtesy of the National Archives, Seattle.

Figure 16. The Hercules office building at the No. 1 quarry (1912). You can just barely see the inscription 'Hercules Sandstone Company' on the lintel above the balcony. From the left: Claus Clodius, William McArthur, A. H. Johnson, and H. P. Scheel. Architectural elements of the Bungalow (upper floor) and Richardsonian–Romanesque (lower floor) architectural styles demonstrated different cut-stone products. Photo courtesy of David Scheel.

tle, talc for the paper mill in Longview, and various talc blocks and products for liners in furnaces and stove tops.

Larry Scheel worked as a stonecutter for Andrew Wilson (1883–1970) at the old No. 1 quarry (renamed Western quarry) in the 1920s and 1930s. Around 1940, Larry worked for Robert 'Bert' Walker (1892–1971) on the trade-named Walker-Wilkeson sandstone at the Walker Cut Stone Company in Tacoma. After being wounded while fighting for the U.S. Navy in World War II, he moved to Union on Hood Canal where he worked for many years for the Mason County Public Utilities District.

Larry cut stone for the old Thurston County Courthouse (1930), Olympia; the Mason County Courthouse (1929), Shelton; and the 1411 Fourth Avenue Building (1929), Seattle. Later, he carved the stone representing Washington State in the Philadelphia Freedom Monument (1987), Philadelphia, Penn. He was accepted into the national Journeyman Stone Cutters Association as its youngest member when he started his trade in Tenino around 1925.

Historian Art Dwelley wrote that "The old Thurston County Courthouse across from the capitol campus in Olympia was one of the last [major] buildings to be built of Tenino stone. The stone eagles over its portico are a final tribute to the dying skill of stone carving." Larry carved those eagles (Fig. 18).

For about 45 years, Hercules Quarry No. 1 remained quiet. In the mid-1980s, Louis Guinett (Guinett Masonry, Vancouver, Wash.) salvaged old stockpiles at the quarry for the Key Bank (formerly Puget Sound Bank) building in Tenino. In 1992, Doug Remmick of Northwest Stone (Tualatin, Ore.) started to quarry stone on a regular basis. In 1998, Marenakos Rock Center of Issaquah took over operations at the site. It is now called the Hercules quarry.

Today stonecutter and carver Keith Phillips works independently at the quarry (Fig. 19). Larry Scheel taught Keith to carve stone and gave Keith his old stone tools to continue the trade. Keith uses them today. This tradition of passing on the tools was once common. Keith's tools are engraved with the initials of the many stonecutters that have used them since the early 1900s (including Larry's initials).

A love of stone, rocks and geology are still pervasive among the descendants of H. P. Scheel. Walt's son David (now

Figure 17. Eversharp Pulp-Burr stone from Heinie's Silica Camp near Marblemount (ca. 1930s). The silica mine was located on top of a ridge and had a gravity system to let the silica down the mountain, about 2,000 feet in elevation. The pulpstone is loaded for transport to the Longview paper mill. 'Pug' the cook (left) (given name unknown), Larry Scheel (right). Photo Courtesy of Larry Scheel.

Figure 18. Larry Scheel's carved Art Deco eagles (1930) ornament the reduced Classical architecture of the old Thurston County Courthouse, Olympia, Wash. Photo courtesy of Gaye Scheel.

retired) was a successful geophysicist who worked worldwide in the petroleum industry. Heinie's grandsons, Bill and Michael Sterling, independently operate retaining wall and landscaping stone businesses near Deming (at Van Zandt) and on Orcas Island, respectively. Other relatives live in residences either constructed with or landscaped by stones and minerals from the numerous quarries founded by the Scheels. Many significant structures throughout the Northwest are built of stone from the Scheel family and remain as a legacy of their love of stone through the generations.

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Editor's note: The author would appreciate hearing from anyone who has information about old quarries or historical photos of the stone industry. The author has applied for a copyright of this material.

Erratum

No one was given credit for the photo of Eocene footprints on p. 29 of *Washington Geology*, v.25, no. 4, December 1997. That credit belongs to Dave Knoblach, who says that the footprints have since been obliterated by a rockfall.

Figure 19. Keith Phillips and his trefoil foliated (as in foliage) archway for the Stading residence in Woodland. It was hand cut from the rough in Tenino sandstone. Photo courtesy of Keith Phillips (ca. 1994).

PACIFIC MINERAL MUSEUM COMING SOON

After delays for structural upgrades to its heritage building, the Pacific Mineral Museum is set to open Nov. 6 at 848 W. Hastings St. in the heart of Vancouver, B.C. It features three galleries using 'superlative mineral specimens to produce awe-inspiring exhibits'. The introductory gallery, adjacent to the retail shop on the first floor, will include displays from the world of minerals. The main gallery, on the second floor, will feature regional mineralogy, anecdotal displays, and mineral objects d'art. The museum's finest gem and mineral treasures will occupy the vault, also on the second floor. The museum will also be exhibiting specimens from the University of British Columbia collection. For more information, contact Mark Mauthner, Pacific Mineral Museum Society, 1500 - 625 Howe St., Vancouver, B.C., Canada V6C 2T6; 604/806-3164; mauthner@pop.interchange.ubc.ca.

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New Webmaster for NWGS Website

Paul Manganelli is the new webmaster for the NWGS website at http://www.scn.org/tech/nwgs/. The web site has been completely redesigned and now includes employment listings and resumes. The e-mail address for NWGS web page information is p2m2@mindspring.com.

BOOK REVIEW: Oregon Fossils

by Elizabeth L. Orr and William N. Orr
Kendall/Hunt Publishing Co.
paperback or softcover
1999, 381 p., $40.95

The Orrs have done it again—a meaty volume of geologic information to follow their recent *Geology of the Pacific Northwest*. This book consists of eight chapters that cover major fossil groups—plants, marine invertebrates, land animals and birds, as well as trace fossils. There is a hefty bibliography as well. What the reader actually gets is an introduction to the fossils and where they are found by way of the people who have worked on them. There are line drawings and a few photos of the fossils and many portraits and black and white snapshots of the late greats, some recently retireds, and those now at work. The verbal portraits are fascinating. We learn a good deal from the photos about the rigors of collecting and from the text, about the politics and lifestyles of the paleontologists. And, yes, they do have senses of humor. And yes, it wasn't easy for women to get through that door before the mid-1950s. If you want to find out how your favorite paleontologist died or what he/she looked like in its prime, this is the book.

This book is not a beginner's guide to fossil collecting, although each chapter closes with a map (Oregon at about 7 inches wide) that displays selected major localities by age. The Orrs tell us in the preface that this is not an exhaustive treatment. The drawings do not have scales, but this is not a problem for the seasoned fossil hunter. The reference list, all 18 pages, has plenty of fodder for more reading. The most recent citation is 1997.

The Orrs cover the current controversies and challenges as well. The change in scientific focus from the mid-1800s to the present is brought out in the biographical material. From my perspective as a radiolarian specialist, I was pleased to see these tiny timekeepers discussed and the introduction to the complexity of the Baker terrane (and nearby terranes) to which rads have made some significant contributions.

This book should be of interest to Washingtonians because, as we all know, geology doesn't stop at political boundaries. Many of the names (fossil and human) will be familiar to local aficionados.

I think this book should have a subtitle: A history of paleontology in Oregon. There are a few annoying things about the book—sometimes text by the photo does double duty[?], sometimes the photo credit is given but the name of the person is left for you to associate, there are some dates missing in the reference list, and the whole book looks over-inked although the photos came through pretty well, but these are minor.

As an accompaniment to a class in Oregon geology, it would be invaluable. Go take a look at this new book. You'll be tempted, and I hope you give in.

Kitty Reed

Index to Washington Geology, 1997–1998

Each issue also contains a list of recent additions to the library's collection and announcements of upcoming meetings.

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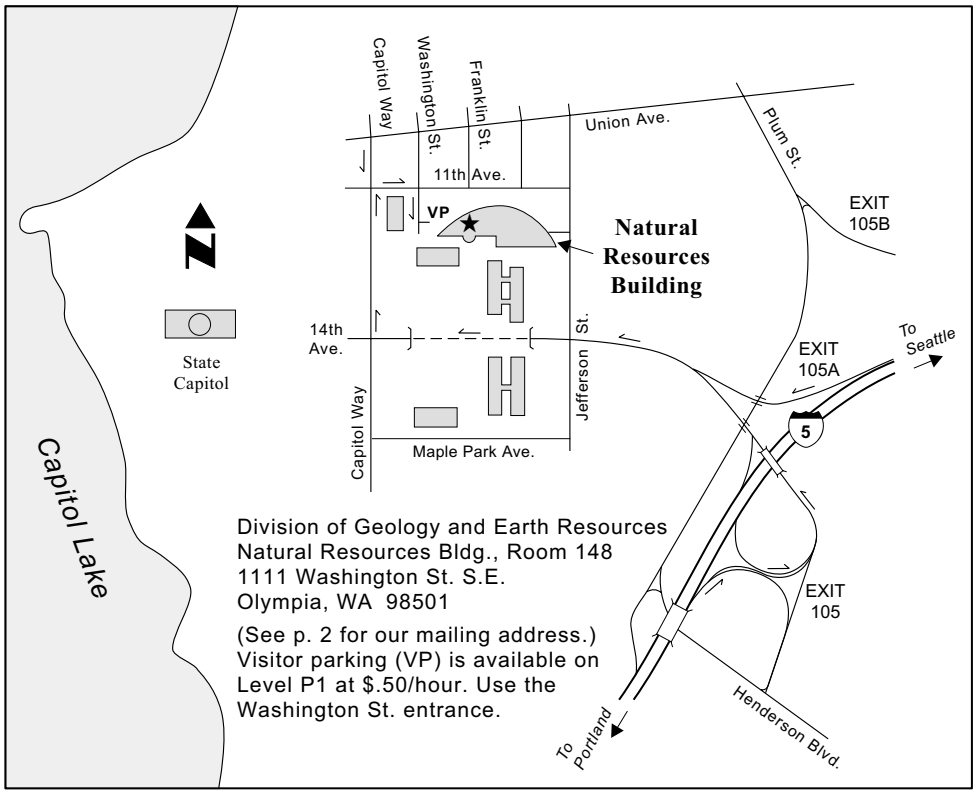

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EXHIBIT REVIEW: Scary Fishes from Deep Time

The Burke Museum of Natural History and Culture at the University of Washington has mounted a new exhibit of fossil fish and paintings of these creatures, as well as jars of preserved modern fish. There is an evolutionary theme to the display as visitors are led from the most primitive and earliest fish through Cenozoic examples and on to modern representatives. The exhibit is housed in the space next to the permanent exhibit of "Life and Time in Washington".

The title of the exhibit is derived from the lurking hunters and curious shapes of the ancient fish shown in about 30 paintings by D. W. Miller. Many of these works are included in J. G. Maisey's 1996 book, Discovering Fossil Fishes. Miller has prepared the "portraits" in acrylics, overlaying pastels, which has resulted in art with a fine matte finish as well as interesting textures. A major challenge for the Burke staff was framing and hanging these delicate paintings.

In cases beside the paintings are fossil or modern examples of the fish or the features that characterize major changes in anatomy. Particularly well represented are sharks and rays. Liz Nesbitt, curator of invertebrate fossils, assembled the array of fossils. Some of the material on display came from the Burke collection; some has been borrowed from other museums or is on loan from individuals. Ted Pietsch is responsible for the displayed preserved fish. Both

Continued on next page

WASHINGTON STATE GEM & MINERAL CLUB UPDATE

CORRECTIONS

The following club listings are corrections of the list of Washington State gem and mineral clubs published last issue. Our apologies to list compiler Cathrine Kenner for omitting her byline in the previous issue. She made calls to all the clubs she could reach to check the accuracy of our information. We hope those of you in the collecting community will continue to keep us up-to-date on these listings.

FORT LEWIS

Fort Lewis Rock Club
Mary Snyder, President (msynder@localaccess.com)
Eleanor Miller, Secretary
514 Carlyon Ave SW; Olympia, WA 98501
Meetings: First Monday, 7:00 pm
MWR Arts and Crafts Center, Bldg #5038
2nd & Pendelton Ave; Fort Lewis, WA

PUYALLUP

Puyallup Valley Gem & Mineral Club
Pam Dugan, President (253)531-2484
Dug Dugger (Saty3Dug0@aol.com)
Meetings: Second & Fourth Friday, 7:30 pm
Fruitland Grange Hall; 112th St E & 87 Ave E

SEATTLE

Boeing Employees Mineralogical Society
The Boeing Co., Box 3707 MS-8L-35; Seattle, WA 98124-2207
Tod Stevens, President (Tod.Stevens@PSS.Boeing.com)
Greg Heck, Secretary (425)204-0282
12358 SE 98th Pl; Renton, WA 98056
Keith Morgan, Editor (253)862-8201 (draggin@foxinternet.net)
3802 W Tapps Dr; Sumner, WA 98390
Meetings: Second Thursday, 7:30 pm
Boeing Activities Center, Rm B; 22649 83rd Ave S; Kent, WA

WASHOUGAL

Washougal Gem Club, Inc.
The club has disbanded

ADDITIONS

WENATCHEE

Blewett Rock Club
c/o Chelan County Historical Society
PO Box 22; Cashmere, WA 98815
Mike Edgett, President (509)782-3230 (cchspvm@aol.com)
Meetings: Fourth Wednesday, 7:00 pm
Chelan County Museum; 600 Cotlets Way, Cashmere, WA

STATE/NATIONAL/INTERNATIONAL

Fluorescent Mineral Society (FMS)
Dr. Rod Burroughs, President (71543.3343@compuserve.com)
PO Box 572694; Tarzana, CA 91357
Don Newsome, NW Regional Vice Pres. (uvsystems@aol.com)
(1-888-228-9988) 16605 127th SE; Renton, WA 98058
(NW regional meeting scheduled once a year during the summer)

DIVISION PUBLICATIONS

New Releases

Deep-Seated Landslide Inventory of the West-Central Olympic Peninsula, Open File Report 99-2, by Wendy J. Gerstel. This 38-page report comes with 2 plates, scale 1:48,000. Landslides were identified from air photos, supplemented by field checks where possible. The report is intended for land managers, planners, and scientists making land-use decisions.

Geologic Folio of the Olympia–Lacey–Tumwater Urban Area, Washington: Liquefaction Susceptibility Map, Geologic Map GM-47, by Stephen P. Palmer, Timothy J. Walsh, and Wendy J. Gerstel. The map is intended to provide land-use planners, emergency-response personnel, engineering consultants, building owners and developers, insurance providers, and private citizens with a relative assessment of the likelihood of soil liquefaction during an earthquake. 16 p. text, 1 plate, scale 1:24,000.

(Our address and phone number are on p. 2. Orders must be prepaid. Make check or money order payable to the Department of Natural Resources. Taxes apply to Washington residents only. Please include $1.00 for postage and handling of orders to be sent by mail.)

SCARY FISHES FROM DEEP TIME *Continued*

whole fish and skeletal remains are exhibited, some as modern examples of the ancient fish groups, others as "variations on the themes" of swimmers and preservation techniques.

The labels on the specimens and art are distillations of volumes of technical information. These are suitable for people new to the history of fish, but there is plenty of meat in them for the scientist.

In keeping with the Burke's mission to provide educational experiences for all ages, there is a table of activities for children, and parts of the exhibit are "hands on".

If you are in Seattle this summer, take your whole family and visitors to the Burke. This exhibit closes in January, but don't wait till the last minute!

Kitty Reed

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Jennifer M. Belcher - Commissioner of Public Lands

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